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Source: Florida Entomologist, 93(1) : 8-23

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.093.0102

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PHALACROCOCCUS HOWERTONI, A NEW GENUS AND SPECIES OF SOFT SCALE (HEMIPTERA: COCCIDAE) FROM FLORIDA

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ABSTRACT

A new soft scale genus *Phalacrococcus* Hodges & Hodgson **gen. nov**. and a new species *Phalacrococcus howertoni* Hodges & Hodgson **sp. nov**., is described from Florida, United States. The adult female and adult male, male and female second-instars, first-instars, and pupa are described and illustrated. Host records, biology, and distribution information are provided.

Key Words: Soft scales, *Phalacrococcus howertoni*

RESUMEN

Se describe un nuevo género de escama blanda, *Phalacrococcus* Hodges & Hodgson **gen. nov**. y una nueva especie, *Phalacrococcus howertoni* Hodges & Hodgson **sp. nov**., de la Florida, Estados Unidos. Se describen e ilustran los adultos hembra y macho, los segundos estadios de la ninfa de la hembra y el macho, el primer estadio y la pupa. Se provee un registro de las plantas hospederas, la biología e información sobre la distribución.

The Coccidae (soft scales) are the third largest family of scale insects (Hemiptera: Sternorrhyncha: Coccoidea) with approximately 1200 described species (Ben-Dov 1993). There are approximately 106 species (representing 29 genera) of soft scales known from the United States (Miller et al. 2007) and 43 species have been found in Florida (representing 18 genera) (Ben Dov et al. 2009; SCALENET Region Query).

Soft scale insects can be serious pests, especially when they are invasive species. Miller & Miller (2003) noted that there were 42 introduced soft scale species in the United States of which 41 were considered to be pests. Records maintained in the entomology section of the Florida Department of Agriculture & Consumer Services, Division of Plant Industry (FDACS-DPI) indicate that there have been approximately 255 invasive arthropod species introduced into Florida over the last 20 years. Of those introductions, only 1 soft scale (*Ceroplastes rusci* (Linnaeus)) has become established in Florida.

The species discussed in this paper was first collected by Lynn Howerton (Florida Department of Agriculture and Consumer Services- Division of Plant Industry plant inspector) on the stems of a croton (*Codiaeum variegatum* (L.) A. Juss.) from Monroe County, Florida in Apr 2008. Since the initial find, there have been a total of 343 specimen submissions of this species to the FDACS-DPI representing collections in 21 Florida counties. Nonetheless, this new species is believed to be established in the natural environment in 5 counties, where it has been recorded from 72 plant host species in 34 families (Table 1).

MATERIALS AND METHODS

Sample Collections And Specimen Preparation

Field specimens were obtained from collections made by FDACS-DPI plant inspectors and University of Florida extension personnel. Live specimens were collected from natural areas and from nursery settings. Specimens were cleared in 10% potassium hydroxide (KOH), stained in McKenzie's stain (equal portions of acid fuschin, erythrosin, and lignin pink in aqueous solution), dehydrated in a series of ethyl alcohol baths and clove oil, and mounted in Canada Balsam. Descriptions for each of the life stages are based on multiple mounted specimens. Illustrations follow the standard format as used for scale insects, with the dorsum shown on the left side and venter shown on the right side. Special features are enlarged to the side of each illustration. The terminology used for the description of the adult female follows that of Hodgson (1994). The collection data for the material studied are followed by the number of slides, with the total number of specimens in parentheses.

Specimen Depositories. AUCC: Auburn University Coccoidea Collection, Auburn, Alabama, U.S.A.; BMNH: The British Natural History Mu-

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TABLE 1. HOST PLANTS OF *PHALACROCOCCUS HOWERTONI* HODGES & HODGSON NOT UNDER PROTECTIVE CULTIVATION.

Species	Family
Acalypha wilkensiana (Muell.-Arg.) Fosberg	Euphorbiaceae
Alocasia sp.	Araceae
Annona muricata L.	Annonaceae
Ardisia escallanoides Schltdl. & Cham	Myrsinaceae
Averrhoa carambola L.	Oxalidaceae
Bidens alba L. (DC.)	Asteraceae
Blechum brownei Juss.	Acanthaceae
Bursera simaruba L.	Burseraceae
Capparis cynophallophora L.	Capparaceae
Calocasia esculentum L.	Araceae
Callophyllum sp.	Guttiferae
Calyptranthes pallens Griseb.	Myrtaceae
Chamaesyce hirta (L.) Millsp.	Euphorbiaceae
Chrysobalanus icaco L.	Chyrsobalanaceae
Chrysophyllum cainito L.	Sapotaceae
Citharexylum spinosum L.	Verbenaceae
Clausena lansium Skeels	Rutaceae
Clusia species	Guttiferae
Coccoloba diversifolia Jacq.	Polygonaceae
Coccoloba uvifera (L.) L.	Polygonaceae
Codiaeum variegatum (L.) A. Juss.	Euphorbiaceae
Conocarpus erectus L.	Combretaceae
Cupania glabra Sw.	Sapindaceae
Digitaria sp.	Poaceae
Dimocarpus longan Lour.	Sapindaceae
Dodonaea vicosa (L.) Jacq.	Sapindaceae
Eclipta prostrata (L.) L.	Asteraceae
Elaeocarpus sp.	Elaeocarpaceae
Eugenia axillaris (Sw.) Willd.	Myrtaceae
Fatoua villosa (Thunb.) Nakai.	Moraceae
Ficus aurea Nutt.	Moraceae
Ficus mysorensis L.	Moraceae
Ficus microcarpum L.	Moraceae
Filicium decipens Wight & Arn.	Sapindaceae
Glycosmis pentaphylla	Rutaceae
Guajacum sanctum L.	Zygophyllaceae
Gymnanthes lucida Sw.	Euphorbiaceae
Hamelia patens Jacq.	Rubiaceae
Heliconia species	Musaceae
Jatropha integerrina Jacq.	Euphorbiaceae
Licaria triandra (Sw.) Kostrm.	Lauraceae
Ligustrum japonicum Thunb.	Oleaceae
Manilkara jaimiqui (C. Wright) Dubard	Sapotaceae
Mangifera indica L.	Anacardiaceae
Morus alba L.	Moraceae
Myricianthes fragrans (Sw.) McVaugh	Myrtaceae
Persea americana P. Mill.	Lauraceae
Phyla nodiflora (L.) Green	Verbenaceae
Phyllanthus urinaria L.	Euphorbiaceae
Piper methisteum G. Forst	Piperaceae
Psidium guajava L.	Myrtaceae
Psychotria ligustrifolia (North.) Mill.	Rubiaceae
Psychotria nervosa Sw.	Rubiaceae
Psychotria sulzneri Small	Rubiaceae
Randia aculeata L.	Rubiaceae
Rapanea punctata Lam. Lundell	Myrsinaceae

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TABLE 1. (CONTINUED) HOST PLANTS OF *PHALACROCOCCUS HOWERTONI* HODGES & HODGSON NOT UNDER PROTECTIVE CULTIVATION.

Species	Family
Savia bahamensis Britt.	Euphorbiaceae
Schinus tenebinthifolius Raddi	Anacardiaceae
Sida sp.	Malvaceae
Sideroxylon celastrinum (Kunth) T.D. Pennington	Sapotaceae
Sideroxylon foetidissimum Jacq.	Sapotaceae
Sideroxylon salicifolium (L.) Lam.	Sapotaceae
Spermacoce verticillata L.	Rubiaceae
Spigelia anthelmia l.	Longaniaceae
Spondias dulci Parkinson	Anacardiaceae
Spondias purpurea L.	Anacardiaceae
Tabebuia heterophylla DC. (Britton)	Bignoniaceae
Tetrazygia bicolor (P. Mill.) Cogn.	Melastomataceae
Zanthoxylum fagara (L.) Sarg.	Rutaceae
Zanthoxylum flavum Vahl.	Rutaceae

seum, London, U.K.; FSCA: The Florida State Collection of Arthropods, Gainesville, Florida, U.S.A.; USNM: The National Entomological Collection of the National Museum of Natural History, Beltsville, Maryland, U.S.A.

PHALACROCOCCUS Hodges & Hodgson

Generic Diagnosis: Adult female (Fig.1). Unmounted Material

Adult female approximately 4 mm long by 2 mm wide, green to yellow-green in color, with dark striations on dorsum.

Mounted Material

Oval to almost round; anal cleft about 1/4th-1/5th body length. Dorsum lightly sclerotized in more mature specimens, with more distinct sclerotizations in each stigmatic cleft; dorsum without areolations, and dorsal setae, dorsal tubercles, pocket-like sclerotizations and tubular ducts absent. Preopercular pores present in 2 diverging bands as far forward as the thorax; dorsal microducts and sclerotized simple pores present throughout. Anal plates each with 4 setae near apex; anal ring with 5 pairs of setae. Margin with a single line of strongly spinose setae; stigmatic clefts shallow, each with 3+ blunt stigmatic spines, clearly differentiated from marginal spinose setae. Eyespots on margin. Venter with abundant multilocular disc-pores, mostly with 5 loculi, present on all abdominal and thoracic segments and laterad to mouthparts. Pairs of longer setae present on 3 pregenital abdominal segments. Ventral tubular ducts absent. Antennae 8 segmented. Legs well developed; tibio-tarsal articulation with an articulatory sclerosis; claw digitules both broad; claw without a denticle*.

Second-instar Female (Fig. 2)

Dorsum without dorsal setae but with 4 longitudinal rows of largish simple pores; dorsal microductules apparently absent. Margin with a single line of stout, sharply spinose setae; stigmatic clefts shallow, each with 1-4 (generally 3) blunt stigmatic spines, clearly differentiated from marginal spinose setae. Venter with a submarginal row of microducts; spiracular disc-pores few. Ventral tubular ducts absent. Limbs well developed; claw digitules both broad; claw with a hint of a denticle*.

Second-instar Male (Fig. 3)

Dorsum with minute dorsal setae (but these sometimes not visible), plus 4 rows of largish simple pores. Dorsal microductules apparently absent. Dorsum with dorsal tubular ducts in a submarginal band, plus partial sub-median lines and 2 pairs of radial lines. Margin with a single line of stout, sharply spinose setae; stigmatic clefts shallow, each with 3 blunt stigmatic spines, usually clearly differentiated from marginal spinose setae. Venter with a submarginal row of microducts; spiracular disc-pores few. Ventral tubular ducts absent. Limbs well developed; claw digitules both broad; claw probably with a hint of a denticle*. First-instar nymph (Fig. 4) (sex not determined). Dorsum with submedian lines of dorsal setae, and submedial and submarginal lines of simple pores. Margin with a single line of spinose setae; stigmatic clefts shallow, each with 1 blunt stigmatic spine, clearly differentiated from marginal spinose setae. Venter with a few microducts submarginally; spiracular disc-pores few. Ventral tubular ducts absent. Limbs well developed; claw digitules dissimilar; claw with a minute denticle*.

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Adult Male (Fig. 6)

Head with numerous reticulations; with 2 pairs of simple eyes. Ocular sclerite without setae; gena without setae. Antennae 10 segmented, each just under half total body length; antennal bristles on apical 3 segments all exceptionally long. Fleshy setae short, thick, with a rounded apex, abundant on antennae and legs; hair-like setae very scarce, almost absent from head and body. Wings well developed; hamulohalteres absent. Legs well developed; anterior coxae with coxal bristles. Glandular pouches and glandular pouch setae present, latter with capitate apices. Penial sheath quite long, about 1/4 total body length; aedeagus short, and apparently bifid apically.

[*The claws on the 1st-instar nymphs appear to have a fairly distinct but minute denticle; the second instars appear to have just a hint of a denticle whereas none can be seen on the adult females.]

The generic name derivation, *Phalacrococcus* is derived from the Greek word *phalakros*, bald headed or smooth (referring to the lack of dorsal setae), and *coccus*, from the Greek *coccum*, often used to describe scale insects.

Phalacrococcus howertoni Hodges & Hodgson **spec. nov**.

Material Studied. Holotype ad♀. United States of America, Florida, Monroe County, *Codiaeum variegatum,* Apr 9, 2008, L. Howerton (deposited in FSCA, acc. No. E-2008-2067).

Paratype, ♀♀ United States of America, Florida: Marathon, *Codiaeum variegatum* Apr 2008, L. Howerton (FSCA, E-2008-2067): 3 (8 ad♀♀) (2 ad ♀♀ deposited in USNM, 4 ad ♀♀ deposited in FSCA, 2 ad ♀♀ deposited in BNHM); Miami, *Psidium guajava*, May 2008, E. Camero (FSCA, E-2008-2858): 2 (4 ad♀♀) (2 ad ♀♀ deposited in BNHM, 2 ♀♀ deposited in FSCA); Miami, *Bursera simaruba*, Jun 2008, H. Mayer (FSCA, E-2008-3823): 14(32 ad ♀♀) (16 ad ♀♀ deposited in BNHM, 2 ad ♀♀ deposited in FSCA, 6 ad ♀♀ deposited in AUEC, 8 ad ♀♀ deposited in USNM); Ft. Pierce, *Codiaeum variegatum*, Jun 2008, C. Averoff (FSCA, E-2008-3847): 2 (6 ad ♀♀) (1 ad♀ ♀ deposited in AUCC, 1 ad ♀♀ deposited in FSCA, 4 ad ♀♀ deposited in BNHM); Homestead, *Eugenia axillaris* Jun 2008, L. King (FSCA, E-2008-3997): 2 (4 ad ♀♀) (2 ad ♀♀ deposited in BNHM, 2 ad ♀♀ deposited in FSCA).

Other Material Studied. United States of America, Florida: Miami-Dade Co., Miami, *Codiaeum variegatum*, 6.iii.2009, Juan Torres (E2009-1163-301): 2 (2 pupae); Marathon, *Codiaeum variegatum,* Apr 2008, L. Howerton (FSCA, E-2008-2067, deposited in BNHM): 2 (4 2nd♀♀), 3 (7 2nd♂♂), 3 (8 1st); Miami Beach, *Codiaeum variegatum*, Apr 2008, collector unknown (FSCA, 2008-2538) 1 (1 2nd♀), 2 (4 2nd♂♂); Miami-Dade Co., Homestead, *Alocasia* sp., 13.iv.2009, Juan Menendez (E2609-2160-301), 5 (5 ad♂♂); Davie, *Codiaeum variegatum,* Apr 2008, G. Azore (FSCA-2008-2434) 1 (2 2nd♀♀), 1 (3 2nd♂♂); Davie, *Codiaeum variegatum,* Apr 2008, G. Azore (FSCA, E-2008-2547): 3 (7 2nd♀♀), 3 (8 2nd♂♂); Miami, *Psidium guajava,* May 2008, E. Camero (FSCA, E-2008-2858, deposited in BNHM): 1 (1 2nd♀), 1 (3 2nd♂♂): 2 (4 1st); Miami, *Bursera simaruba,* Jun 2008, H. Mayer (FSCA, E-2008-3823): 2 (2 2nd♀♀), 2 (4 2nd♂♂) 14 (32 1st); Homestead, *Sideroxylon celastrinum,* Jun 2008, L. King (FSCA, E-2008-3998, deposited in USNM): 1 (2 2nd♀♀), 1 (3 2nd♂♂); Ft. Pierce, *Codiaeum variegatum,* Jun 2008, C. Averoff (FSCA, E-2008-3847): 2 (6 1st); Homestead, *Eugenia axillaris*, Jun 2008, L. King (FSCA, E-2008-3997, deposited in USNM): 2 (4 1st).

ADULT FEMALE (Fig. 1).

Described from 6 specimens in fair to good condition.

Mounted material. Oval to almost round, 2.5-5.3 mm long and 1.8-3.25 mm wide (venter slightly narrower, width 1.7-3.1 mm); anal cleft about 1/4th- 1/5th body length.

Dorsum. Derm membranous but becoming mildly sclerotized when mature; with slightly heavier sclerotization in each stigmatic area. Dorsal setae absent. Preopercular pores in 2 diverging elongate groups anterior to anal plates, each group extending anteriorly to about mesothorax and with many pores (100+), these gradually becoming sparser anteriorly; each pore probably almost flat (appearing like a small lens) and rather variable in size, each 4-7 µm wide. Dorsal microductules oval, appearing bilocular, each about 1.5 µm wide, with single inner ductule arising medially, most ductules swollen proximally; frequent throughout. Also with a round pore with a sclerotized outer margin and a small inner pore, which appears similar to a setal basal socket, each about 3 µm wide; also frequent throughout. Dorsal tubercles, pocket-like sclerotisations and dorsal tubular ducts absent. Anal plates each about 135-160 µm long, width of single plate 95-115 µm; each plate triangular with a rather rounded apex, and with 4 setae near apex, each 28-33 µm long (but most missing). Anogenital fold with a pair of large setae on each corner of anterior margin, each about 95-100 µm long, plus 5 moderately large setae along each lateral margin. Anal ring well developed, with 5 pairs of setae, each mostly about 140-170 µm long; anal tube short with anal ring lying under anterior margin of anal plates. Eyespots small, on margin, each about 15-18 µm wide.

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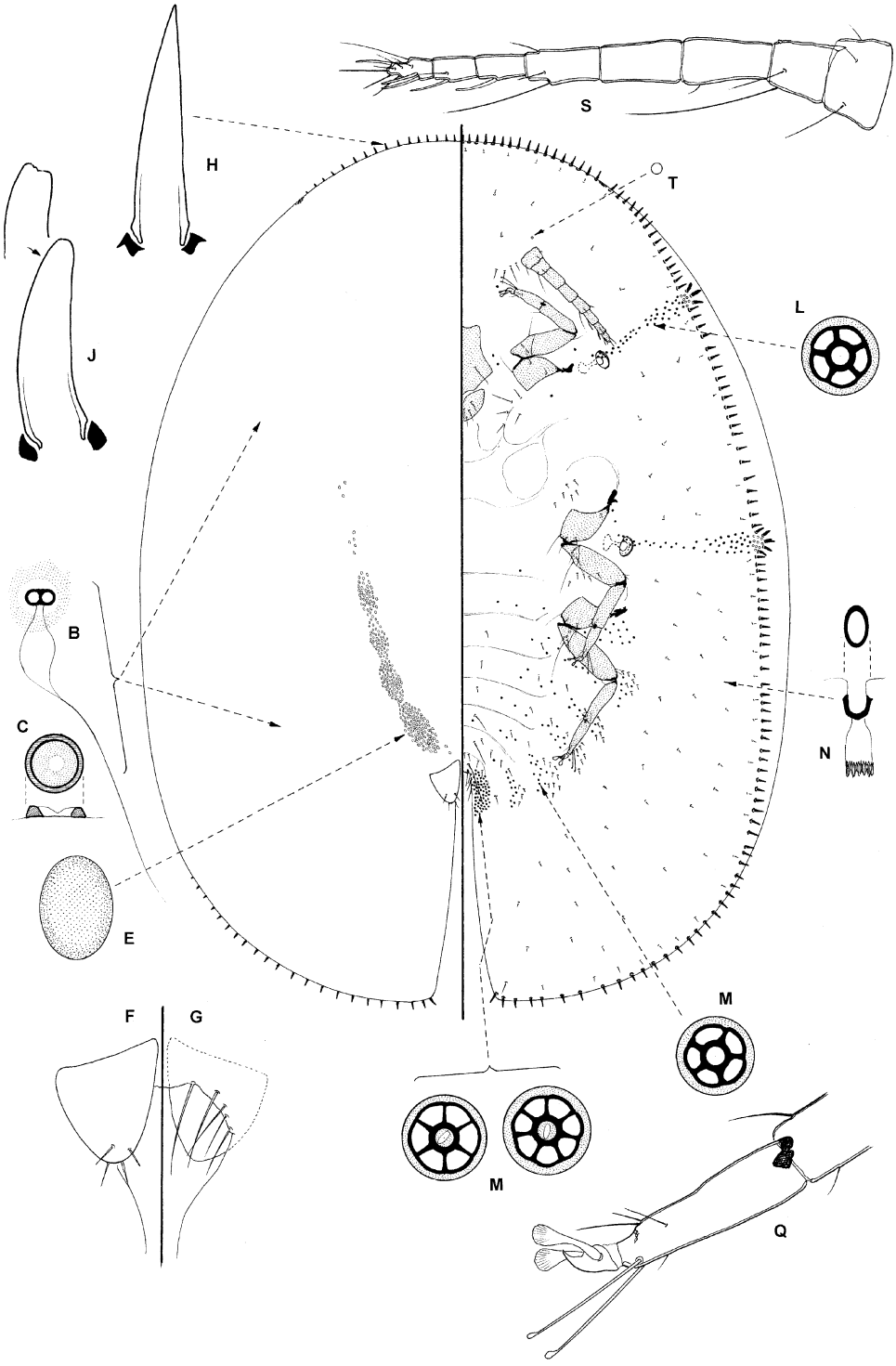


Fig. 1. Adult female *Phalacrococcus howertoni* Hodges & Hodgson. Unless otherwise stated, in this and subsequent figures: A = dorsal seta; B = dorsal microductule; C = dorsal simple pore; D = dorsal tubular duct; E = preopercular pore; F = dorsal view of anal plate; G = ventral view of anal plate; H = stigmatic spine; J = marginal setae; L = spiracular disc-pore; M = multilocular disc-pore; N = ventral microduct; P = ventral seta; Q = part of metathoracic leg; R = anal ring; S = antenna and T = preantennal pore.

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Margin. Marginal setae all rather stout and sharply spinose, each 16-35 µm long, with a narrow basal socket; with 33-39 anteriorly between eyespots and, on each side, 11-20 between eyespots and anterior stigmatic areas, 17-27 laterally between stigmatic areas and 41-65 on each side of abdomen; setae on anal lobes not differentiated. Stigmatic clefts shallow, but each with a small area of denser sclerotization, and each with a rather variable number of stigmatic spines, generally 3, but up to 8 on some specimens, arranged in a semicircle, each clearly differentiated from marginal spines, slightly curved with a rounded or even slightly flattened and abbreviated apex; median spine(s) generally larger than more lateral spines, range 20-35 µm long.

Venter. Derm membranous. Spiracular disc-pores each mainly with 5 loculi, in a band between each spiracle and stigmatic cleft, each band narrow near spiracles and broadening slightly nearer margin; also each band extending a short distance medially anterior to each spiracle; with about 30-50 pores in each anterior band and 45-70 in each posterior band; each band with 5-6 pores within area of sclerotization in each cleft with thickened margins. Multilocular disc-pores: those in segment VII with mainly 6 or 7 loculi; those more anteriorly almost always with 5 loculi; each about 7-8 µm wide; with 22-75 on either side of anterior end of anal cleft, and then as follows (on each side): abdominal segment VI 3-11, V 2-16, IV 5-17, III 7-27, II 1-6 mesad to each coxa + 4-15 more laterally; medially with 0-7 on metathorax, 0-8 posterior to each mesocoxa, 0-4 near each procoxa and 0-2 on each side of clypeolabral shield. Ventral microducts each about 1 µm wide, frequent in a broad submarginal band and rather less frequent throughout rest of venter although absent medially on more posterior abdominal segments. Ventral tubular ducts absent. With a single pair of preantennal pores. Ventral setae sparse; with three pairs of longer pregenital setae (on abdominal segments V-VII), longest about 100-115 µm long; most abdominal segments with 5-10 shorter setae in a group submedially; also with 4-6 setae near each meta- and mesocoxa, and 3 or 4 near each procoxa; with 3 or 4 pairs of interantennal setae, longest about 65-70 µm long; submarginal setae in a rather sparse band rather than a line, each about 20-25 µm long.

Antennae each 8 segmented, total length 355-470 µm; setal distribution typical of Coccidae except segments III & IV with 0 or 1 seta and V with 3 setae; length of apical seta 33-36 µm long. Clypeolabral shield 175-190 µm long; labium probably with 4 pairs of setae. Spiracles of normal size, width of peritremes: anterior 72-90 µm, posterior 85-105 µm. Legs well developed; lengths (µm) of metathoracic legs: coxae 170-205; trochanter + femur 250-270; tibia 165-180; tarsus 95-105; claw 25-29; tibio-tarsal articulation clear, with a distinct articulatory sclerosis; longest coxal seta about 90-100 µm; longest trochanter seta about 135-140 µm; coxa with 7 setae, trochanter 2 or 3 on ventral surface, femur 3 or 4, tibia 3 and tarsus 2; tarsal digitules longer than claw digitules; claw digitules longer than claw, each similar with broad apices; claw without a denticle. Vulva probably present between abdominal segments VII and VIII.

Comment. The adult females of this new species of soft scale share character-states with the Eulecaniinae (absence of dorsal tubercles, pocket-like sclerotisations and dorsal tubular ducts; spinose marginal setae, and multilocular disc-pores extending anteriorly onto thorax and head) but the multilocular disc-pores have 7 or fewer loculi, ventral tubular ducts are absent, the legs have an articulatory sclerosis and the claw digitules are broad. It also has character-states which it shares with the Paralecaniini (absence of dorsal tubular ducts; stigmatic clefts with sclerotizations; multilocular disc-pores with less than 10 loculi; ventral tubular ducts absent) but, again, it has characters that do not fit, namely eyespots on margin and multilocular disc-pores not restricted to posterior abdominal segments. It is close to Coccini but the absence of dorsal setae and the presence of strongly spinose marginal setae etc. makes it different from all known genera included in this group as defined by Hodgson (1994). It is therefore being placed in a new genus, *Phalacrococcus* Hodges & Hodgson but wider relationships remain unclear.

SECOND-INSTAR FEMALE (Fig. 2)

Described from 5 specimens in fair to good condition. Mounted Material. Oval, 0.75-0.93 mm long and 0.45-0.60 mm wide; anal cleft about 1/6 body length.

Dorsum. Derm membranous. Dorsal setae absent (but see notes below). Preopercular pores absent. Dorsal microductules apparently absent. Dorsal simple pores, each about 2-5-3.0 µm wide, in a pair of submedial lines and submarginally; with about 9 pores in each submedial line and about 15 in each submarginal line. Dorsal tubercles, pocket-like sclerotisations and dorsal tubular ducts absent. Anal plates each about 68-70 µm long, plates with apices wide apart; each plate triangular with a rather rounded apex, and with 4 setae, 3 near apex and 1 on each inner margin; length of apical setae 25-30 µm long. Anogenital fold with a pair of setae on each corner of anterior margin, each about 20-25 µm long; each plate also with a ventral lateral margin seta. Anal ring well developed, with 3 pairs of setae, each about 70-95 µm long; anal tube short, anal ring lying under anterior margin of anal plates. Eyespots small, on margin, often obscure, each about 15-18 µm wide.

Margin. Marginal setae all rather stout and sharply spinose, each 7-13 µm long, with a fairly

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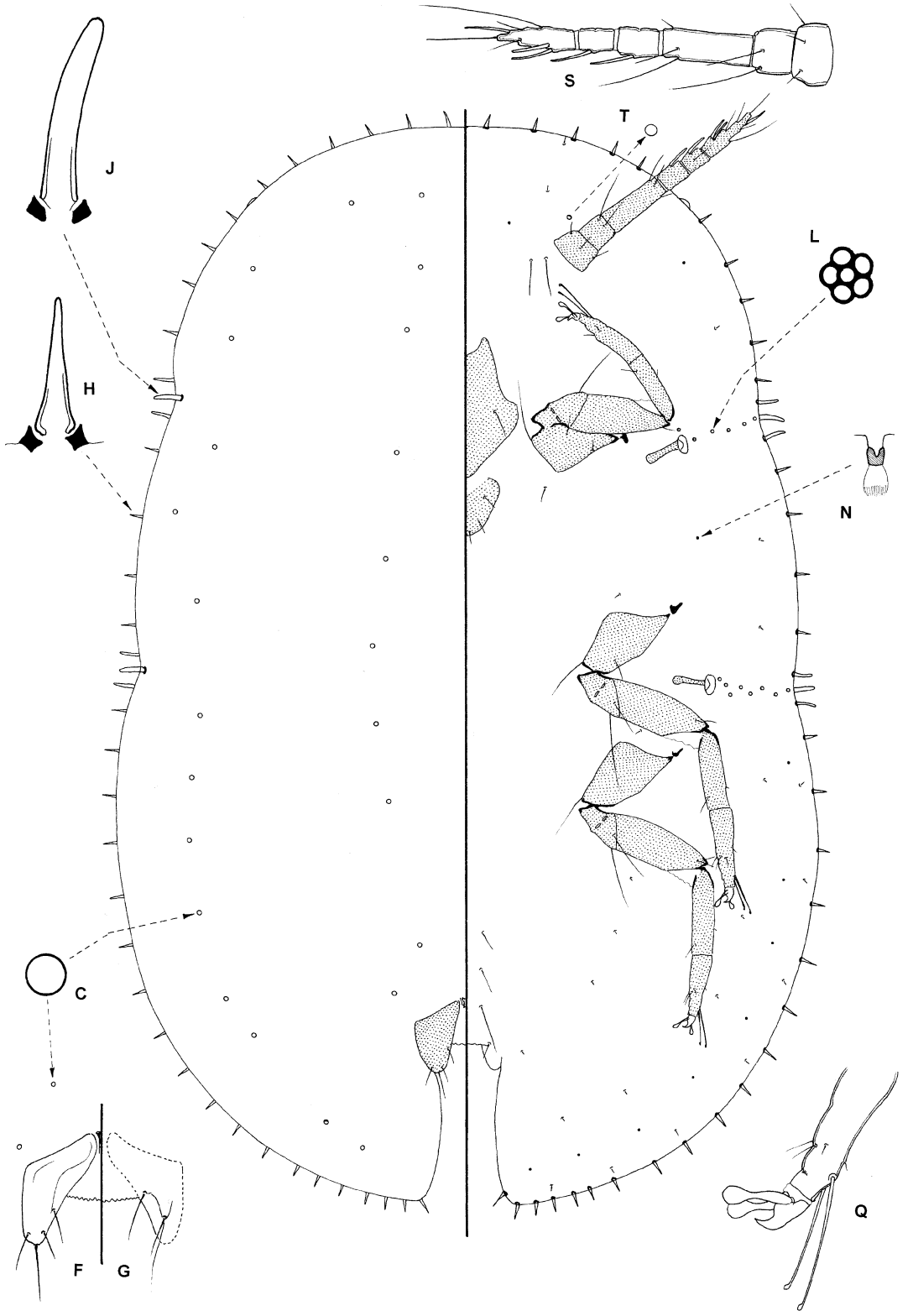


Fig. 2. Second-instar female *Phalacrococcus howertoni* Hodges & Hodgson. For labels, see caption for Fig. 1.

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narrow basal socket; with 12-15 anteriorly between eyespots and, on each side, 4-6 between eyespots and anterior stigmatic areas, 4-7 laterally between stigmatic areas and 16-25 on each side of abdomen. Stigmatic clefts shallow, each with a rather variable number of stigmatic spines, generally 3, but varying from 1-4 on some specimens, each clearly differentiated from marginal spines, often slightly curved with rounded apex; median spine(s) generally slightly larger than lateral spines: median spines 20-27 µm long, lateral 13-19 µm long.

Venter. Derm membranous. Spiracular disc-pores each mainly with 5 loculi (range 4-7), in a more or less single line between each spiracle and stigmatic cleft; with about 4-8 (usually 7 or 8) in each anterior band and 4-10 (usually 8-10) in each posterior band. Multilocular disc-pores absent. Ventral microducts each about 1.5 µm wide, frequent in a submarginal line, with about 8 on each side of abdomen, 2 on each side of thorax and 2 laterally on head; also with a pair between scapes. Ventral tubular ducts absent. Preantennal pores: 1 pair present. Ventral setae sparse; with 3 pairs of longer pregenital setae (on abdominal segments V-VII), longest 58-70 µm long on segment VII; abdomen with a submedian row and inner and outer submarginal rows of small setae, distributed segmentally; outer submarginal row with 1 pair per segment on abdomen, 2 pairs between stigmatic clefts, 1 pair laterally on head and another pair anteriorly on head; with 1 small seta near each coxa, interantennal setae 2 pairs, usually subequal in length, each about 36-45 µm long.

Antennae each 6 segmented, total length 165-185 µm; setal distribution as normal on Coccidae. Clypeolabral shield 100-115 µm long; labium with 3 pairs of setae. Spiracles small, width of peritremes: anterior 14-15 µm, posterior 16-17 µm. Legs well developed; lengths (µm) of metathoracic legs: coxae 68-78; trochanter + femur 98-110; tibia 61-65; tarsus 50-60; claw 16-17; coxa with 5 setae, trochanter 2 on ventral surface, femur 2, tibia 2 and tarsus 4; tarsal digitules sometimes slightly dissimilar, longer than claw digitules; claw digitules longer than claw, similar with broad apices; claw with just a hint of a denticle.

Comment. It was noted that the dorsal setae on some 2nd-instar males (described below) were sometimes apparently absent (but perhaps represented by just their basal sockets) while other specimens had minute setae in the submedian line of simple pores. It is therefore possible that the same could apply to 2nd-instar females (i.e., that they are present on some specimens but only represented by their basal sockets, which are about the same size of the simple pores, on others—as on the above specimens).

Apart from the possible lack of dorsal microductules, the second-instar female nymphs of *P. howertoni* show nothing distinctive.

SECOND-INSTAR MALE (Fig. 3).

Described from 3 specimens in fair to good condition. Material studied. Oval, 0.82-1.50 mm long and 0.57-0.78 mm wide; anal cleft about 1/6 body length.

Dorsum. Derm membranous. Dorsal setae noted submedially on meso- and metathorax on 2 specimens. Preopercular pores absent; dorsal microductules apparently absent. Dorsal simple pores, each about 1.5 µm wide, rather hard to see but apparently in a pair of submedial lines and submarginally; with about 4 or 5 pores in each submedial line and about 14 or 15 in each submarginal line. Dorsal tubular ducts present in a submarginal row, with 10-15 between eyespots, and (on each side) 6-11 between eyespots and anterior stigmatic cleft, 6-8 between clefts and 5-10 along anterior abdominal submargin; also with an anterior radial line from near each eyespot and another in about abdominal segment IV, each with 6-8 ducts; plus a pair of partial submedian bands extending from anterior plates anteriorly, each with about 7 or 8 ducts. Anal plates each about 68-71 µm long, each plate about 30-35 µm wide; plates with apices wide apart; each plate triangular with a rather rounded apex, with 4 setae, 3 near apex and one on each inner margin; length of apical setae 18-21 µm long. Anogenital fold with a pair of setae on each corner of anterior margin, each about 16-18 µm long; each anal plate also with 1 seta ventral lateral margin seta. Anal ring well developed, with 3 pairs of setae, each about 70-95 µm long; anal tube short, anal ring lying under anterior margin of anal plates. Eyespots small, on margin, often obscure, each about 12-15 µm wide.

Margin. Marginal setae all rather stout and sharply spinose, each 7-13 µm long, with a fairly narrow basal socket; with 9-13 anteriorly between eyespots and, on each side, 5-9 between eyespots and anterior stigmatic areas, 4-6 laterally between stigmatic areas and 17-22 on each side of abdomen. Stigmatic clefts shallow, each with 3 stigmatic spines, each generally clearly differentiated from marginal spines, usually straight but occasionally slightly curved, with a rounded apex; median spine(s) generally slightly larger than lateral spines: median spines 12-18 µm long, lateral 13-17 µm.

Venter. Derm membranous. Spiracular disc-pores each mainly with 5 loculi, in a more or less single line between each spiracle and stigmatic cleft; with 7-10 in each anterior band and 8-10 in each posterior band. Multilocular disc-pores absent. Ventral microducts each about 1.5 µm wide, frequent in a submarginal line, with about 8 on

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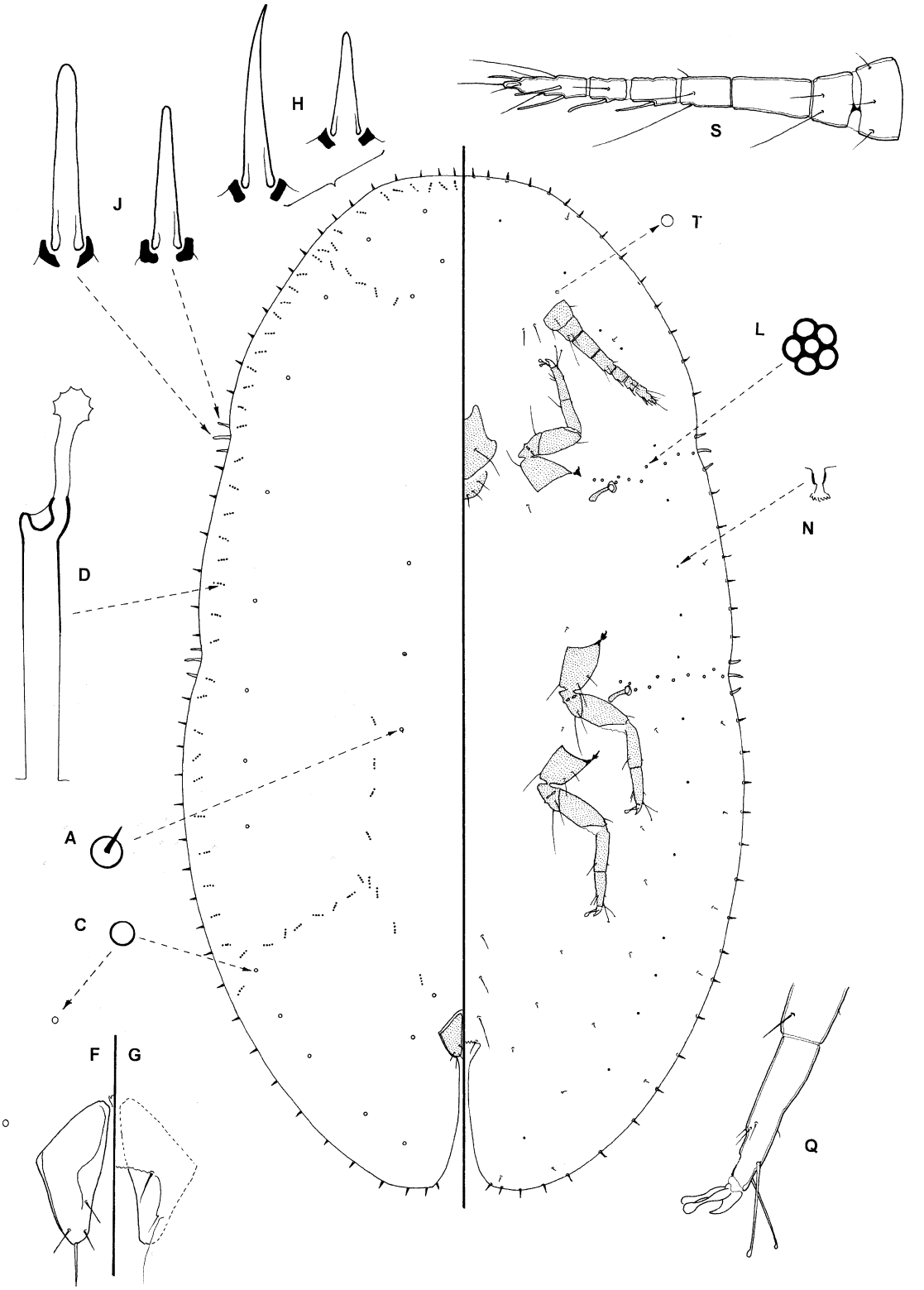


Fig. 3. Second-instar male *Phalacrococcus howertoni* Hodges & Hodgson. For labels, see caption for Fig. 1.

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each side of abdomen, 4 on each side of thorax, 2 laterally on head and 2 anteriorly on head; also probably with a pair between scapes. Ventral tubular ducts absent. Preantennal pores: 1 pair present. Ventral setae sparse; with three pairs of longer pregenital setae (on abdominal segments V-VII), longest on segment VII, each 58-70 µm long; abdomen with segmentally arranged submedian and an inner and outer submarginal rows of small setae; outer submarginal row with 1 pair per segment on abdomen, 1 pair between stigmatic clefts and 1 pair anteriorly on head; also with 1 small seta near each coxa, plus 2 pairs of interantennal setae, usually subequal in length, each about 40-55 µm long.

Antennae each 6 or 7 segmented (when 6 segmented, with a distinct pseudoarticulation in the long segment III), total length 195-211 µm; setal distribution as normal on Coccidae. Clypeolabral shield 85-95 µm long; labium with 3 pairs of setae. Spiracles small, width of peritremes: anterior 13-18 µm, posterior 16-19 µm. Legs well developed; lengths (µm) of metathoracic legs: coxae 80; trochanter + femur 100-115; tibia 66-70; tarsus 53-58; claw 14-15; coxa with 5 or 6 setae, trochanter 2 on ventral surface, femur 2, tibia 2 and tarsus 3 or 4; tarsal digitules sometimes slightly dissimilar, longer than claw digitules; claw digitules longer than claw, each similar with broad apices; claw with just a hint of a denticle.

Comment. Miller & Williams (1997) illustrated the suture distribution on the tests of many second-instar male Coccidae. Most of these tests had complex suture patterns with frequent radial lines. As the dorsal tubular ducts on second-instar males lie under the suture lines in the tests, it is possible to determine the layout of these lines on the test by looking at the dorsal tubular duct distribution on the second-instar male nymphs. None of the suture patterns shown by Miller & Williams quite match that of *P. howertoni*. The pattern shown for *Ceroplastes acaciae* Cockerell is somewhat similar in that the median suture lines appear to be incomplete, but *C. acaciae* lacks the anterior radial lines. In any case, it seems improbable that *P. howertoni* would be closely similar to the Ceroplastinae. Thus it appears that the distribution of the suture lines offers no obvious suggestions as to the nearest relative of *P. howertoni*.

FIRST INSTAR (sex not determined) (Fig. 4).
Described from 5 specimens in fair to good condition and with reference to 7 others.
Material studied. Oval, 0.40-0.61 mm long and 0.25-0.35 mm wide; anal cleft very short.

Dorsum. Derm membranous. Dorsal setae in 2 submedial lines of 5 short setae, each about 2 µm long. Preopercular pores absent; dorsal microductules apparently absent. Dorsal simple pores extremely hard to see but each about 2 µm wide, in submedial lines and submarginally; with perhaps 2 pores in each submedial line on abdomen and perhaps 7 in each submarginal line. Anal plates each about 42-53 µm long, plates with apices wide apart; each plate triangular with a rather rounded apex each with longitudinal ridges on dorsal surface; each with 4 setae, 1 on inner margin and 3 near apex, apical seta very long, each about 160-185 µm long. Anogenital fold with a pair of setae on each corner of anterior margin, each about 13-16 µm long; also each plate with a single ventral lateral margin seta Anal ring well developed, with 3 pairs of setae, each about 40-55 µm long; anal tube short, anal ring lying under anterior margin of anal plates. Eyespots small, on margin, often obscure, each about 10-11 µm wide.

Margin. Marginal setae all rather stout and sharply spinose, each 10-16 µm long, with a fairly narrow basal socket; with 8 anteriorly between eyespots and, on each side, 2 or 3 between eyespots and anterior stigmatic areas, 3 laterally between stigmatic areas and 9 or 10 on each side of abdomen. Stigmatic clefts shallow, each with 1 stigmatic spine, clearly differentiated from marginal spines, often slightly curved with a flattened, rounded apex; each 12-20 µm long.

Venter. Derm membranous. Spiracular disc-pores each mainly with 5 loculi (range 4-7), in a more or less single line between each spiracle and stigmatic cleft; with 3 or 4 in each band. Multilocular disc-pores absent. Ventral microducts extremely hard to see, each about 1.0-1.5 µm wide, present submarginally, with perhaps 1 on abdomen, 1 on thorax and 1 on head. Tubular ducts and preantennal pores absent. Ventral setae sparse; with 3 pairs of longer pregenital setae (on abdominal segments V-VII), longest 40-53 µm long; abdomen with an inner and outer submarginal row of small setae, segmentally arranged on abdomen, plus 1 pair between stigmatic clefts and 1 pair anteriorly on head; setae near each coxa absent; with 1 pair of interantennal setae, each about 30-38 µm long.

Antennae each 6 segmented, total length 150-160 µm; setal distribution as normal on Coccidae. Clypeolabral shield 70-80 µm long; labium with 3 pairs of setae. Spiracles small, width of peritremes 6.5-8.0 µm. Legs well developed; lengths (µm) of metathoracic legs: coxae 43-48; trochanter + femur 68-76; tibia 36-43; tarsus 36-43; claw 15; coxa with 5 setae, trochanter 2 on ventral surface, femur 2, tibia 2 and tarsus 4; tarsal digitules offset and dissimilar, 1 shorter than other; subequal in length to claw digitules; claw digitules longer than claw, dissimilar; claw with a minute denticle.

Comment. The first-instars of *P. howertoni* are typical soft scale crawlers except that they appear to lack the "trilocular" pore which is generally

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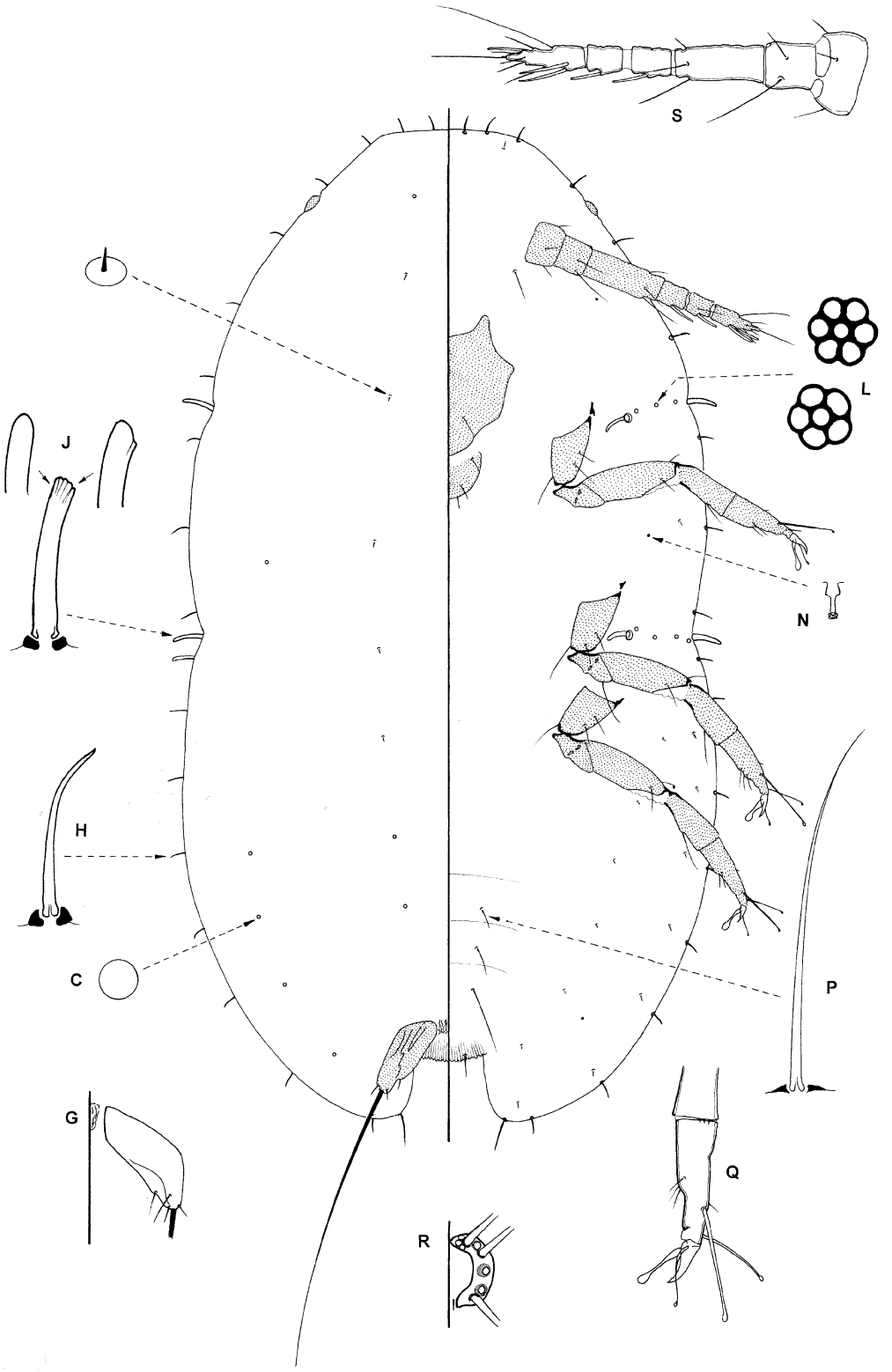


Fig. 4. First-instar *Phalacrococcus howertoni* Hodges & Hodgson. For labels, see caption for Fig. 1.

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present near the dorsal anterior margin of the head. The apparent lack of dorsal microductules may be related to the condition of the slides although they were not detected on the 2nd-instars either.

PUPA (Fig. 5)

Described from 2 specimens, 1 poor.

Mounted Material. Elongate oval. Division into head, thorax and abdomen fairly clear, although segmentation often obscure apart from on abdomen. Derm membranous, with small dermal spinules. All ducts and pores (bar spiracular disc-pores) absent and setae few. Of moderate size: length 1.12-1.2 mm; head width 312-341 µm.

Head. Lacking mouthparts and simple eyes. With a pair of moderately long, 10-segmented antennae pointing posteriorly, extending posteriorly almost to mesocoxae (ratio of total body length to antennal length about 1:0.35; apical segment pointed, apparently without incipient setae; basal segments slightly to moderately sclerotized; total length 475-480 µm. Setae: with 2 pairs of minute setae on apex of head.

Thorax. Unsclerotized, segmentation obscure. Legs well-developed; coxa and trochanter slightly sclerotized; prothoracic legs probably generally directed anteriorly and curving round in front of anterior margin of head but not on available specimens; metathoracic legs extending posteriorly to about abdominal segment V; coxae with a minute seta; length of metathoracic legs 490-540 µm. Wing-buds extending to about anterior margin of abdomen; mildly sclerotized; length 460-485 µm, width 110-156 µm (ratio length to width 1:0.28). Spiracles: width of peritremes 26-30 µm; anterior spiracles each with 9-12 disc-pores anterolaterally to each peritreme; posterior spiracles with 0-2 disc-pores; number of loculi in each disc-pore highly variable, from 1 to 15 or more. Setae: with one pair medially on dorsum of mesothorax and another pair medially on venter of metathorax.

Abdomen. Segmentation usually distinct, anterior-most segment on venter considered to represent segment II, so that there are 7 visible segments (segments II to VIII) anterior to penial sheath. Caudal extensions of segment VII lobe-like, about half length of penial sheath. Setae: with pairs of small dorsal abdominal setae medially on segments III-VII and two pairs of small ventral abdominal setae on segments III-VI; dorsopleural setae quite large, each 15-20 µm long more or less in a line from segment VII to segment IV, those on caudal extension of segment VII similar, plus single setae on 1 or 2 more anterior segments; ventropleural setae: single short setae on segments II-VII. Caudal extension of segment VIII represented by a pair of obscure membranous lobes dorsally on either side of base of penial sheath, each with 2 minute fleshy setae. Anteanal setae absent. Penial sheath lightly sclerotized, more or less triangular, 115-130 µm long and 85-95 µm wide at base (ratio length to width 1:0.74); with 2 pair of small pores or setae on dorsal surface. Anus not located.

Comment. Relatively few pupae of soft scales have been studied but of those studied, the presence of spiracular disc-pores near the posterior spiracle appears to be unusual and few have a line of dorsal pleural setae along the margin of the abdomen, as on some species of *Crystallotesta*-most pupae have the dorsal pleural setae arranged segmentally.

ADULT MALE (Fig. 6).

Described from 5 specimens in good condition.
Unmounted material: not seen.

Mounted material. Moderately large, total body length 1.5-1.63 mm; width across triangular plates 0.36-0.38 mm; body quite broad.

Head: approximately diamond-shaped in dorsal view; length 220-245 µm; width across genae 230-250 µm. Median crest (mc) reticulated dorsally; with 4-6 small hs dorsal head setae (dhs) on each side. Ventral mid-cranial ridge (vmcr) represented by a sclerotized ridge between scapes; area between vmcr and scapes with faint ridges or reticulations; with 2-4 pairs of ventral mid-cranial ridge setae (vmcrs). Genae (g) strongly reticulated, each reticulation with numerous inner microridges: genal setae absent. Eyes: with 2 pairs of round, simple eyes, subequal in size, each 35-40 µm wide; anterior pair near anterior margin of head and posterior se close to posterior margin. Ocelli (o) slightly oval, each about 17-20 µm widest laterally. Ocular sclerite (ocs) strongly polygonally reticulated, each reticulation with a 1 or 2 inner micro-ridges. Preocular ridge fairly short but distinct. Interocular ridge absent. Postocular ridge (pocr) well developed but short, not nearly reaching ocelli. Dorsal ocular setae absent. Ventral head setae absent. Cranial apophysis (ca) Y-shaped, about 45-55 µm long. Preoral ridge (pror) well developed.

Antennae: total length about 675 µm long (ratio of total body length to antennal length about 1:0.42). Scape (scp): 40-55 µm long and 40-42 µm wide, with 3 hs. Pedicel (pdc): 35-37 µm long, 45-50 µm wide; with 3-7 hs on dorsal surface. Segments III-X all about 25-33 µm wide; lengths of segments (µm): III 53-70; IV 66-115; V 80-83; VI 80-83; VII 73-83; VIII 75-77; IX 66-73, and X 48-60; fs each about 18-21 µm long (i.e. much less than width of segment), with a rounded apex; extremely abundant; hs absent; each segment often with a basal seta very similar to an antennal bristle. Segment VIII and IX each with an exceptionally long antennal bristle (ab); segment X with a

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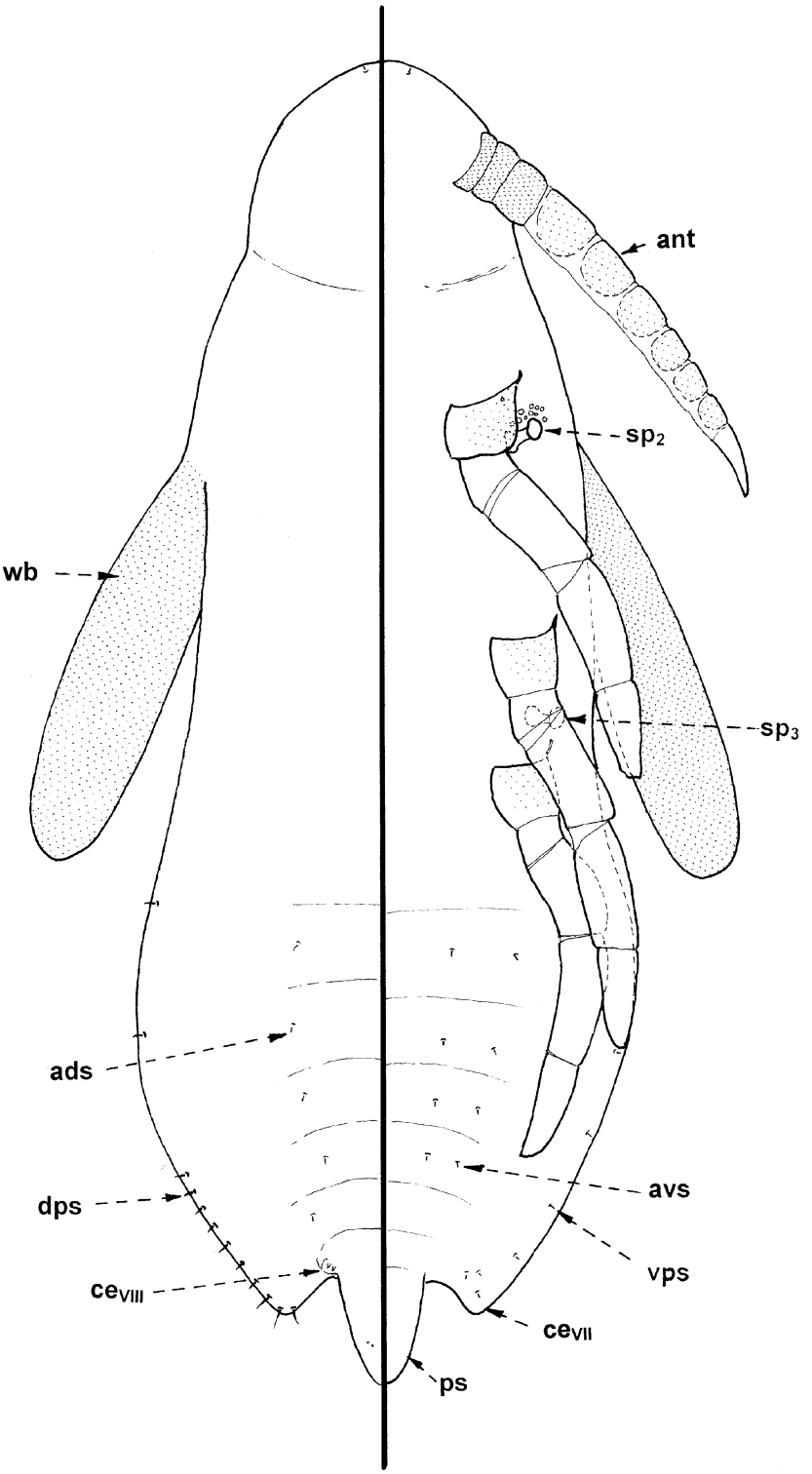


Fig. 5. Pupa *Phalacrococcus howertoni* Hodges & Hodgson. Where ads = dorsal abdominal setae; ant = antenna; avs = ventral abdominal setae; ce_{VII} = caudal extension to segment VII; ce_{VIII} = caudal extension to segment VIII; dps = dorsal pleural setae; sp_2 = anterior spiracle; sp_3 = posterior spiracle; vps = ventral pleural setae and wb = wing bud.

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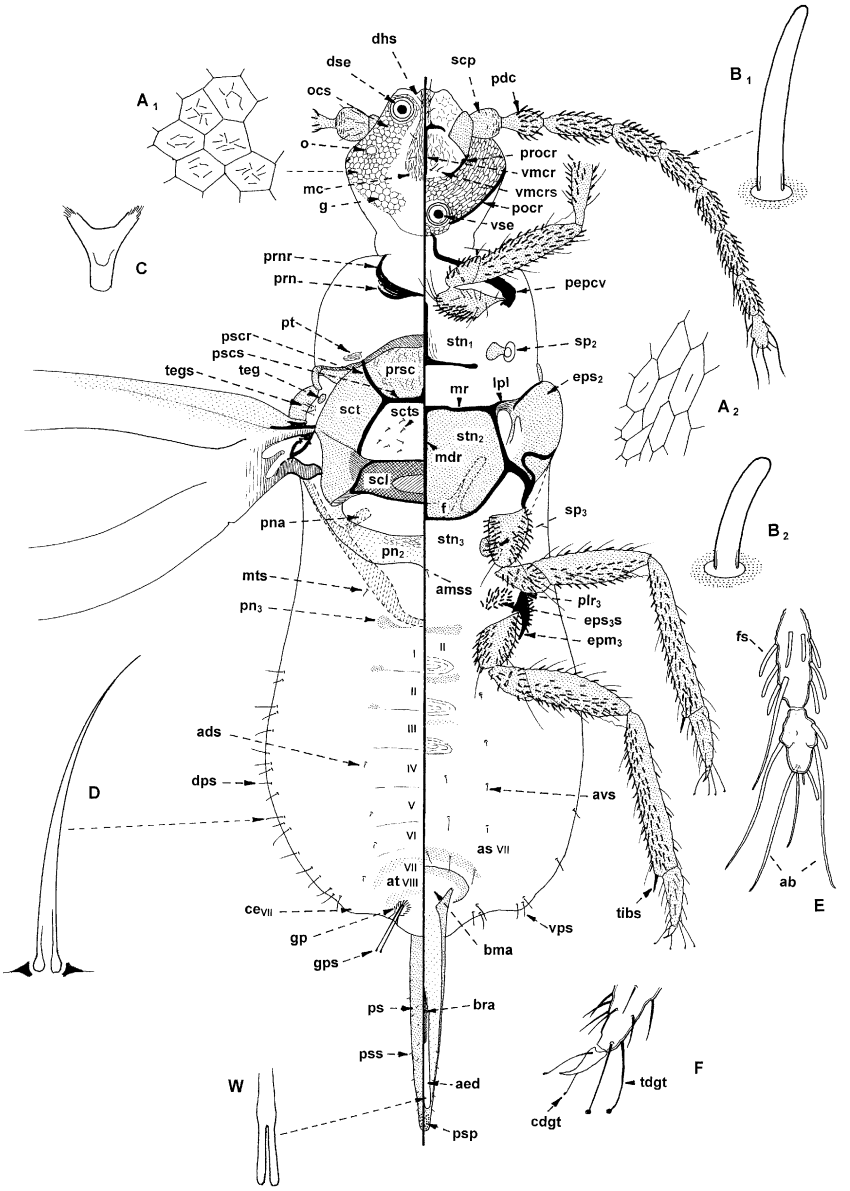


Fig. 6 = Adult male *Phalacrococcus howertoni* Hodges & Hodgson. Where: A_1 = polygonal reticulations on gena; A_2 = polygonal reticulations on ocular sclerite; B_1 = fleshy seta on antenna; B_2 = fleshy setae on legs; C = cranial apophysis; D = hair-like dorsal pleural seta; E = apical 2 segments of antenna (note that apical segment is usually longer than shown), and F = distal end of metathoracic leg. And where: ab = antennal bristles; ads = dorsal abdominal setae; aed = aedeagus; amss = anterior metasternal setae; as = abdominal sternite; at = abdominal tergite; avs = ventral abdominal setae; bma = basal membranous area; cdgt = claw digitule; ce = caudal extension; dhs = dorsal head setae; dps = dorsal pleural setae; dse = dorsal simple eye; epm_3 = metepimeron; eps_2 = mesepisternum; eps_3s = postmetaspiracular setae; f = furca; fs = fleshy seta; g = gena; gp = glandular pouch; gps = glandular pouch setae; lpl = lateropleurite; mc = midcranial ridge; mdr = median ridge; mr = marginal ridge; mts = metatergal setae; o = ocellus; ocs = ocular sclerite; pdc = pedicel; pepcv = proepisternum + cervical sclerite; plr_3 = metapleural ridge; pn_2 = mesopostnotum; pn_3 = metapostnotum; pna = postnotal apophysis; pocr = postocular ridge; prn = lateral pronotal sclerite; prnr = pronotal ridge; procr = preocular ridge; prsc = prescutum; ps = penial sheath; pscr = prescutal ridge; pscs = prescutal suture; psp = penial sheath pores; pss = penial sheath setae; pt = post-tergite; scl = scutellum; scp = scape; sct = scutum; scts = scutal setae; sp_2 = anterior spiracle; sp_3 = posterior spiracle; stn_1 = prosternum; stn_2 = basisternum; stn_3 = metasternum; tdgt = tarsal digitule; teg = tegula; tegs = tegular setae; tibs = tibial spur; vmcr = ventral midcranial ridge; vmcrs = ventral midcranial ridge setae; vps = ventral pleural setae, and vse = ventral simple eye.

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few fs (some may be short ab) + 3 exceptionally long ab; each bristle 80-110 µm long; capitate setae absent.

Thorax. Prothorax: pronotal ridge (prnr) strong and not fused medially; pronotal sclerite (prn) broad. Post-tergite lightly sclerotized with ridges. All pronotal setae absent. Prosternum (stn_1) strongly sclerotized with a well-developed median ridge and transverse ridges; all prosternal setae absent. Proepisternum + cervical sclerite (pepcv) well developed; propleural ridge quite large; propleural apophysis well developed.

Mesothorax: prescutum (prsc) 185-207 µm wide and 100-112 µm long, probably rather convex in life; with slight indications of nodulations; without prescutal setae; prescutal ridge (pscr) and prescutal sclerite (pscs) well developed. Scutum (sct): median membranous area 165-190 µm wide and 75-104 µm long, with 4-8 hs scutal setae (scts) on each side; sclerotized lateral areas without nodulations or setae; area laterad to scutellum more heavily sclerotized. Prealare ridge (prar) well developed but narrow, terminating in a well-developed anterior notal wing process. Scutellum (scl) 185-215 µm wide and 66-70 µm long; with a large foramen; scutellar setae absent. Mesopostnotum (pn_2) underlying metapostnotum (pn_3); postnotal apophysis (pna) normal; area within mesopostnotum membranous. Prealare and triangular plate well developed. Mesepisternum (eps_2) rather small, without nodulations. Basisternum (stn_2) about 250-275 µm wide and 170-175 µm long; with a narrow, complete median ridge (mdr); marginal ridges well developed; furca (f) with arms extending anteriorly to about halfway to marginal ridge (mr). Lateropleurite (lpl) relatively small, possibly with a membranous centre. Postalare (pa) not reticulated at anterior end but perhaps with a few striations; postalare setae absent. Mesothoracic spiracle (sp_2): peritreme 33-35 µm wide; disc-pores absent. Postmesospiracular setae absent. Tegula (teg): with about 3-5 hs tegular setae (tegs).

Metathorax. Metatergal seta (mts): with 1 hs on each side. Metapostnotum (pn^3) present. Dorsospiracular setae (dss) absent. Dorsal part of metapleural ridge (plr_3) absent; ventral part broad. Metepisternum (eps_3) unsclerotized, with a dense group of about 20 fs postmetaspiracular setae (eps_3s). Metepimeron (epm_3) heavily sclerotized; base of metapleural ridge and metepimeron with a dense group of perhaps 20 fs. Antemetaspiracular setae absent. Metathoracic spiracle (sp_3): peritreme 27-33 µm wide; without disc-pores. Metasternum (stn_3) unsclerotized. Anterior metasternal setae (amss): 1 hs medially; posterior metasternal setae absent. All structures associated with hamulohalteres absent.

Wings: about 1075-1125 µm long and 472-525 µm wide (ratio of length to width 1:0.45; ratio of total body length to wing length 1:0.70). Without alar lobe or alar setae. Hamulohalteres (h) absent.

Legs: metathoracic legs marginally longer than others, with numerous fs, each slightly shorter than those on antennae but equally broad and blunt apically. Lengths (in µm) coxae (cx): I 99-112; II 95-112; III 105-110 µm long; setae of coxa III: a few hs + many fs; procoxae with a group of pointed coxal bristles. Trochanter (tr) + femur (fm): I 235-252; II 230-257; III 223-252 µm long; trochanter III with 2 long hs + many fs; femur III with many fs and a few hs. Tibia (ti): I 248-265; II 240-277; III 260-303 µm; tibia III with many fs + a few hs; some more distal setae becoming spur-like; with 1 apical spur (tibs), length (III) 25-28 µm. Tarsi (ta): I 99-108; II 95-102; III 99-103 µm long (ratio of length of tibia III to tarsus III 1:0.36); tarsus III with 0-1 fs and several hs, some spur-like; tarsal spurs (tabs) not differentiated; tarsal campaniform pore absent; tarsal digitules (tdt) longer than claw, subequal in length to claw digitules, both with capitate apices. Claws (c): length (III): 25-27) µm, subequal to width of tarsus; claw digitules both with small clubbed apices.

Abdomen. Tergites (at) on segments I, II, VII and VIII lightly sclerotized; sternites (as) of segments II, III, IV, VII and VIII sclerotized; pleurites (ap) unsclerotized. Caudal extension (ce) of segment VII very small, that on VIII absent. Dorsal abdominal setae (ads) extremely few, with pairs of short hs on segments IV-VII. Pleural setae: dorsopleural setae (dps): with a line of rather longer hs setae extending from about segment II-VII, longest about 25-30 µm long; ventropleural setae (vps) sparse, with 3 on segment VII and VIII, and single on V and VI (and maybe sometimes on IV). Ventral abdominal setae (avs) very sparse, with 1 pair of short hs on segments III and IV and 2 or 3 pairs on segments V-VII. Segment VIII without ante anal-setae. Glandular pouches present, each deep and divided into inner and outer chambers; each with a pair of glandular pouch setae with capitate apices and 85-100 µm long.

Genital Segment. Penial sheath (ps) quite long with almost parallel sides; 370-395 µm long and about 50 µm wide near middle (ratio of total body length to penial sheath length 1:0.24). Basal rod (bra) short but rather variable in length, 70-170 µm long, not nearly reaching basal membranous area anteriorly (bma). Aedeagus (aed) short, 125-135 µm long; apex appears to be divided. Penial sheath with about 12 small penial sheath setae and with a group of pores on apex.

Comment. Less than 100 adult male Coccidae have been studied in detail but the male of *P. howertoni* is immediately separable from them in having: (i) exceptionally long antennal bristles on antennal segments VIII-X (much longer than the segments), and (ii) extremely short, thick fleshy

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setae with a blunt apex on antennae and (in particular) legs. These setae much more closely resemble the fleshy setae on some male Eriococcidae than those usually found on Coccidae. In addition, it has the following unique combination of other characters: (i) absence of setae on ocular sclerite; (ii) presence of a dense group of fleshy postmetaspiracular setae and metepimeron setae (the only fleshy setae on body derm); (iii) capitate glandular pouch setae; (iv) aedeagus apparently bifid apically, and (v) extreme paucity of hair-like setae on body derm. Because of these unique characters, it is not possible to suggest any close phylogenetic relatives.

Economic Importance. Large populations of soft scales are frequent and can cause much leaf loss and some twig and limb dieback on larger woody hosts (Kosztarab 1996). In a few cases, smaller plants have dies, particularly those of *Codiaeum*. Like most soft scales, *P. howertoni* eliminates large quantities of honeydew and this inhibits photosynthesis and encourages sooty mold.

Life Cycle. Under the ecological conditions in Florida, *P. howertoni* has multiple overlapping generations a year, averaging about one a month. It overwinters as the adult female and each female can lay about 400 eggs.

Natural Enemies. Some natural enemies have been noted. Predators: *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) has been reported as a major predator on heavily infested material; and *Laelilla coccidivora* Comstock (Lepidoptera: Pyralidae) has been recorded from a few samples from southern Florida. In addition, the parasitoid *Metaphycus flavus* (Howard) (Hymenoptera: Encyrtidae) has been noted quite often but has only been found in about 3% of specimens in any 1 collection.

Taxonomic Position: This new soft scale genus and species shows similarities to members of the Eulecaniinae, Paralecaniini, and Coccini but varies significantly from all these taxa. Its taxonomic relationships, therefore are uncertain and no suggestions can be made at the moment to the geographic region from which this species originated.

Acknowledgments

GSH thanks the Florida Department of Agriculture and Consumer Sciences-Division of Plant Industry for collection of specimens and processing of specimens and Dr. Catharine Mannion and Lyle Buss from the University of Florida for photographs and life history information. CJH thanks The National Museum and Galleries of Wales, Cardiff, for the help and encouragement in his research.

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